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Short Synopsis

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Development of Optimized Handoff Decision Algorithm for Wireless Networks

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This is to declare that this short synopsis reflects the research work design and its contents are the original piece of work, as per guidelines, grammatically correct and free from plagiarism. This has been prepared under the guidance and supervision of my supervisor/joint-supervisor.

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ABSTRACT

Since the last few decades, tremendous innovations and inventions have been observed in every field, but especially in wireless network technology. The prevailing demand curves and trends in this particular area of communication shows the need/importance of real time multimedia applications over several networks with guaranteed quality of service (QoS). To meet the demands of customers, Next Generation Wireless Network (NGWN) system will offer more advanced services like global roaming with high data transfer rate and a seamless mobility over a diverse range of heterogeneous wireless network.

The wireless technology beyond 3G is also known as Next Generation Wireless Network (NGWN). It consists of heterogeneous wireless networks that will grant high data rate and bandwidth to mobile users. The primary aim of Next Generation Wireless Network (NGWN) is to allow users to have maximum gain anywhere and anytime. Hence, current trend in communication network is to conceal heterogeneities and to achieve convergence of diverse networks to provide seamless mobility. So that mobile user can move freely between networks without losing the connection or changing the setting at any moment. When the mobile user moves between different networks, there is a requirement to hand over the channel, from one network to another by considering its services, features and user preferences. Channel handover between two different networks is done with the help of vertical handoff (VHO). However, in a heterogeneous environment numerous technologies co-exist with their unique characteristics. Therefore, it becomes difficult to choose the best network among alternatives to perform an efficient handoff.

This research will cater to overcome the problem of decision making through a decision making model which will help the user to decide the best network at best time among available networks based on various factors, such as received signal strength (RSS) of network, velocity of mobile stations, offered bandwidth, cost, user preference, jitter, delay and type of application. This model fulfills the requirements of individual and improves the whole system performance by reducing the number of vertical handoffs and call dropping probability [Goyal, Pramod, et al., 2008] [18].

Keywords: Vertical Handoff (VHO), Next Generation Wireless Network (NGWN), Received signal strength (RSS), Quality of service (QoS).

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Introduction:

In present wireless systems, the cellular networks have large capability of broader coverage, but limited bandwidth and high network cost. On the other hand, Wireless Fidelity (Wi-Fi), Wireless Local Area Network (WLAN), Worldwide Interoperability for Microwave Access (Wi-MAX) and Universal Mobile Telecommunications (UMTS) have smaller coverage and high bandwidth. Therefore, Next Generation Wireless Network (NGWN) integrates heterogeneous technologies, mainly 3G and IEEE 802.XX in order to combine the advantages of each of them, i.e. the high coverage of 3G and the high bandwidth of IEEE 802.XX. The integrated network of Next Generation Wireless Network (NGWN) introduces the new concept of Always Best Connected (ABC). This allows accessing the communication services anytime, anywhere with the best quality of service (QoS) at minimum cost.

In the heterogeneous access networks, internetworking is intended to provide mobile users uninterrupted connectivity when moving across different network. The convergence of networks, increases the coverage of the network and hence the continuity. It offers speed and applications beyond 3G or 4Gs and differs in respect of signal strength, coverage area, data rate, latency and packet loss. The Next Generation Wireless Network (NGWN) supports a seamless mobility and handoff between different networks and devices. It allows the consumer to get equipped with multiple network interfaces, and can jump between diverse networks without any errors or interruption in running applications, in such a way that maximizes the user satisfaction and minimizes the usage cost. To minimize the network usage cost with maximum utility for accessing different technologies, a seamless and efficient Vertical handoff (VHO) is must. Handoff or Handover is the process of transferring a mobile station from one base station or channel to another [Reed, Jeffrey H, 2002] [36]. In other words, handoff refers to the process of changing the communication channel (frequency, data rate, modulation scheme, spreading code or their combination) associated with the current connection, a communication session or call is in progress [Kahraman, Beycan, and Feza Buzluca, 2013] [25].

Literature Survey:

- In 1999, Wang, Helen J., Randy H. Katz, and Jochen Giese [47] proposed a call admission policy based on network perspective and user perspective. From user perspective, the admission control provides facility to the user, i.e. required quality of service (QoS) level, bandwidth, minimum cost. Whereas from network perspective admission control forces the handover to a different network for achieving the load balancing between candidate networks. Although, there are various policy based proposal for handoff decision. Most of them consider the user perspective. These proposals increase the user satisfaction at the cost of network instability as user competes for network resources regardless of network condition. On the other hand, the network controlled algorithm ignores the user preferences and quality of service (QoS) requirement. Therefore, there should be an optimal admission control algorithm, which considers both user and network aspects. This algorithm makes a balance between user admission and network conditions. Therefore, it requires that the user must express their choices in the form of rule, not as value for switching to another network. The complexity arises due to complex rules which results in an ambiguous handoff decision.

- In 2004, Chen, Ling-Jyh, et al. [13], introduced a small and simple model to choose the best network among available alternatives at the appropriate time. In this paper, they have designed a handoff control centre module, which collects information from the available interfaces and systems by monitoring them so that the required handoff decision can be taken. The decision is based on the score function that considers various factors like usage cost, link capacity and power consumption for the available access technologies. The network that achieves the highest score is chosen by the mobile terminal (MT). In this algorithm, various factors have been taken into consideration like cost, power consumption, bandwidth, received signal strength, mobile terminal velocity. These parameters are used as input and to remove undesired network to improve the overall efficiency. It increases the performance by reducing unnecessary handoffs. However, the proposed model is applicable for only

soft vertical handoff using application layer approaches like universal seamless handoff architecture (USHA).

- In 2006, Zhang, Jie, et al. [50] proposed a Vertical handoff algorithm to maximize user satisfaction by means of a utility function. They have predicted the mobility pattern of a mobile terminal based on its movement and location topology and have utilized this information for handoff decision based on user satisfaction framework. Whenever a mobile terminal receives a signal from more than one network, it gives its position information and preference of services to location service server (LSS). The location service server (LSS) predicts the user's future movement based on its mobility history and then decides whether to handoff to another network or not. The proposed scheme enhances the user satisfaction and reduces the harmful handoff. But the proposed work is user centric and enhances the user satisfaction without considering the network overloading, traffic & congestion.

- In 2008, Ayyappan, K., and P. Dananjayan [5] proposed an algorithm that evaluates the performance of vertical handoff algorithm, when a mobile node moves in (from the cellular network to WLAN) and moves out (from WLAN to cellular network) by measuring received signal strength (RSS) using the appropriate propagation model. Received signal strength (RSS) is the measurement of power present in a received radio signal. The received signal must have enough power to maintain signal quality at receiver. The power of received signal gets weaker as it moves away from base station and gets stronger as it gets closer to base station. They have calculated the received signal strength (RSS) using the propagation model for different types of wireless network. The propagation models are useful to predict path loss or attenuation free received signal strength (RSS). In this algorithm, the reliability of handoff decision depends on accuracy of received signal strength (RSS). Therefore, more powerful method can be used in future for improving the accuracy of received signal strength (RSS).

- In 2011, Bosoanca, Ionut, and Anca Vargatu [11] proposed an intelligent handoff management process. It is based on Fuzzy Logic (FL), Multiple Criteria (MC) and Analytic Hierarchy Process (AHP) and always best connected (ABC) algorithm. The Always best connected (ABC) algorithm is used to initiate the handoff process. Once the handoff process is initiated, the information from the mobile and network (Quality of service (QoS), bandwidth, packet delay, packet loss, user preference, capabilities, battery, network interfaces, application used in real time or not, terminal location, speed etc.) is collected. The collected information is given as input to a Fuzzy Logic and the output of Fuzzy Logic is given to an Analytic Hierarchy Process (AHP) to analyze the output.

- In 2010, He, Daojing, et al. [15] Proposed a simple and robust two step vertical handoff decision algorithms keeping in mind that mobile node have limited battery power, which is a critical parameter. In this, handoff decision depends on dynamic new call blocking probability (DNCBP) and resources of a mobile node. For a resource poor mobile node, the handoff decision finds the candidate network by calculating the minimum service requirement function. It indicates whether the basic services required by the mobile node are supported by the available network or not. Whereas for resource rich mobile nodes extended vertical handoff function calculates the benefits gained by mobile terminal after switching. The algorithm is based on available bandwidth, dynamic new call blocking probability (DNCBP) and received signal strength (RSS). It provides the optimum utilization of bandwidth. In future, we can use packet loss to enhance this approach.

- In 2011, Radhika, K., and A. Venugopal Redd. [34] Proposed a vertical handoff decision algorithm based on Bayesian Evolutionary game model. In this algorithm, when a mobile terminal achieves a signal from more than one wireless network, it performs network selection iteratively to achieve best quality of service (QoS) with minimum cost. The decision algorithm tries to find an equilibrium point at which the quality of network access service is maximized and the cost of service is minimized. This solution is termed as Bayesian Nash Equilibrium. In their algorithm,

the handoff decision problem was solved as a non- cooperative game between the mobile node and the access network that were available in the surrounding area of the mobile user. It considers terminal parameters such as quality of service (QoS) requirement of the mobile application along with the velocity of the mobile terminal and cost per bit offered by each network. The algorithm allows the mobile user to avail the highest quality of service (i.e. the highest bandwidth, supported velocity and lowest packet delay, jitter and bit error rate) with minimum cost per bit offered by each network. They reduce the handoff delay in scanning the available network with the help of a media independent handover framework. But, the authors have not considered the number of handoff made by mobile node. If the numbers of hand off are more than the specified limit, then it consumes more battery power, which is a crucial parameter.

- In 2011, Savitha, K., and C. Chandraseka [37] proposed a handoff decision model to choose the best network from the available network. In this, handoff decision is based on the comparison between the neighbor network quality of service (QoS) and the mobile user quality of service (QoS) (i.e. offered bandwidth, processing delay, usage cost and jitter). The handoff decision depends on the weighted sum of all the attributes of a candidate network. They have worked on handoff decision phase to reduce the processing delay in the process of handover. But a very few parameters (offered bandwidth, processing delay, usage cost and jitter) are considered for handoff decision. Performance can be further enhanced by including the parameters like packet loss and error rate.

- In 2012, Vetrivelan, P., and P. Narayanasamy [45] proposed a seamless media independent resilience triggering (SMRIT) framework for providing decision based on received signal strength (RSS), bandwidth, and transmission delay and packet loss. It provides the seamless roaming across the heterogeneous network through the media independent handover framework without user intervention. The selection of network is based on the highest value of quality factor, which is a function of bandwidth,

delay, cost & throughput. The proposed framework, aims to minimize new call blocking probability (NCBP), handoff call dropping probability (HCDP) and to efficiently utilize the system resources. The algorithm accepts or rejects the new call to avoid the overloading in a network. Their framework has been simulated by using NS3 and it greatly reduces the transmission delay, packet loss, decision processing delay, handover blocking rate and new call dropping rate. But in this algorithm, new call blocking probability (NCBP) decreases with a fixed adaptability ratio (β). In future, there should be an algorithm which should define the optimal value of (β) which will suit for real time 4G wireless network.

Description of Broad Area:

Handoff in Wireless network:

When a mobile node moves into a different cell during a call, the mobile switching centre (MSC) automatically transfers the call to a new channel belonging to the new base station [Huang, L, et al., 2001] [22]. This process is known as handoff. Depending on the access network that each point of attachment belongs to, the handoff can be classified in two parts [Bin Ma; Xiaofeng Liao and Xianzhong Xie, 2013] [10]:

i) Horizontal handoff

ii) Vertical handoff

i) Horizontal Handoff (HHO): Horizontal handoff occurs among two base stations (BS) of the same network (same access technology). Horizontal Handoff can be further divided into Intra cell and inter cell Handoff [Benny Bing, 2005] [7].

a) Intra cell handoff: It occurs when a mobile user moves to a new cell under the same base station in order to minimize inter channel interference [Huang, Lei, et al., 2001] [22].

b) Inter cell handoff: It occurs when a mobile user moves to a new cell, which is served by different base stations. All the existing connections are transferred to the new base station [Chen, Jyh-Cheng, and Zhang Tano, 2004] [13].

ii) Vertical handoff (VHO): The vertical handoff changes the mobile node active connection between various wireless access points. Vertical handoff can be further classified as:

a) Upward and downward handoff: Vertical handoff can be separated as upward and downward based on the coverage of a source and target networks. In an upward hand off, the mobile device switches from smaller coverage to a larger coverage. On the other hand, in downward hand off the mobile device switches from a network of larger coverage to a smaller coverage.

b) Hard and Soft handoff: In a hard handoff the mobile device connects to a new base station only after disconnection from the previous base station [Chen, Jyh-Cheng, and Zhang Tano, 2004] [13]. On the other hand, in soft handoff a mobile node maintains the connection with the previous base station till it completes the connection with the new base station. This process is also called as make before break because the mobile device maintains simultaneous connections with both the base stations.

C) Imperative and Alternative handoff: An imperative handoff occurs when signal strength from a current access point decreases. On the other hand, an alternative handoff occurs to provide the user better services. In this handoff decision is based on various parameters like available bandwidth, threshold velocity of network, usage cost of the network, quality of service required by the application and user preferences.

d) Mobile controlled and network controlled handoff: Handoff decision can be controlled by a mobile or network. Depending on who is controlling the handoff decision, it can be subdivided as:

i) Mobile controlled Handoff (MCHO): In this, handoff decision is taken by the mobile only.

ii) Network controlled Handoff (NCHO): The handoff decision is controlled by the network only [Krichene, Neila, and Noureddine Boudriga, 2009] [27].

iii) Mobile controlled network assisted (MCNA): The handoff decision is taken by a mobile device, but with the help of the network. This is a more suitable method

because only mobile devices have the knowledge about the network interface and user preferences [Krichene, Neila, and Noureddine Boudriga, 2009] [27].

iv) Network controlled Mobile assisted (NCMA): The handoff decision is taken by the network, but the data required for handoff is collected with the help of mobile device [Krichene, Neila, and Noureddine Boudriga, 2009] [27].

Vertical Handoff (VHO) decision making parameter:

In heterogeneous networks, vertical handoff (VHO) is initiated for providing better performance rather than for connectivity reasons. Therefore, the handoff decision may depend on various parameters as [Vasu, K., et al., 2011] [44]:

a. Bandwidth: Bandwidth is a measure of handling the traffic load. The higher the bandwidth, lower will be call dropping and call blocking probability.
b. Handoff Latency: The delay can occur during the handover of calls between two base stations. This hold up time is known as handoff latency. A high-quality handoff decision model should have minimum handoff latency.
c. Power Consumption: Power is consumed when a mobile node switches between networks and during the handoff process. Therefore, when the battery level of mobile node decreases, then switching to a network having low power consumption can provide extended usage time. For example, if a mobile node battery is almost worn out, then switching from a WLAN to WWAN would be a beneficial decision [Bosoanca, Ionut, et al., 2011] [11].
d. Network Cost: Vertical handoff (VHO) algorithms should consider the network cost because different charging policies are used by various access domains.
e. User Preferences: Based on the application requirements like (voice, data, and video) the user may prefer different networks according to the network performance.
f. Network Throughput: Network throughput is the average data rate of a particular communication link.

g. Network Load Balancing: Network traffic must be taken into account during efficient handoff. It is essential to balance the load to avoid degradation in quality of service (QoS).

h. Network Security: The security feature is not well built in some wireless access technologies. Therefore, to achieve the maximum level of reliability, validation and confidentiality, the network security feature should be implanted in the handoff algorithms.

i. Received Signal Strength (RSS): The received signal strength (RSS) should not be underneath a certain threshold in a network throughout handoff. The received signal strength (RSS) must have to be strong enough to maintain the signal quality at the receiver.

j. Velocity: Velocity of the mobile device is an important parameter for handoff decision [Siddiqui, F., et al., 2009] [39]. For example, if a mobile device is moving at a high speed then switching to smaller coverage is not valuable because a handoff to the actual network would occur very soon [Chen, Jin, et al., 2012] [12].

It is essential to consider maximum numbers of parameters during vertical handoff (VHO). But it is difficult to consider all the metrics in a single decision model as it increases the battery requirement of the mobile device and complexity of algorithms.

Motivation:

The next generation wireless network (NGWN) architecture will be an integration of various heterogeneous wireless access networks over an IP (Internet protocol) backbone. Therefore, in the near future the mobile users will not be bound by a subscription of a single service. They can choose any available network of their own choice without changing the setting or reconnections depending upon the needs and type of application. In future, choosing the appropriate network at the appropriate time will be a requirement.

The Problem Description:

Mobility management is a main challenge in next generation wireless network (NGWN) due to heterogeneous environment. It addresses two main problems – Location management and handoff management. Location management tracks the mobile node, whereas handoff management maintains the active connection; when a mobile node changes their location. In a heterogeneous network both Horizontal and Vertical handoff take place. The main distinction between them is symmetry. Horizontal handoff is a symmetric process, while Vertical handoff is an asymmetric process in which mobile node moves between two different networks. This introduces a problem of a preferred network and to associate the mobile node with the preferred network. Also, the handoff should be seamless with minimum user intervention.

So far, significant research has been done to reduce the ping-pong effect, unnecessary harmful handoff, handoff latency, bandwidth utilization, Packet delay, Packet loss etc. But many of existing handoff algorithms do not consider the quality of service (QoS) of an ongoing session to maximize the end user satisfaction based on their preferences, location and application contexts. Various factors like available bandwidth, signal strength, preferred interface, usage cost, power consumption, mobile terminal location, mobile terminal velocity, congestion, type of application should be considered while performing the handoff decision. Also, proper weight assignment is very important to guarantee the quality of the currently utilized service. Therefore, in this research we optimize the vertical handoff algorithm by considering the parameters predicted received signal strength (PRSS), velocity of the mobile station, user preferences, cost of the service, available bandwidth (B.W), received signal strength (RSS), jitter, delay and type of application.

Objectives:

The development of wireless technology aims to provide the flawless uninterrupted connection to access diverse wireless technologies and to have connectivity with the best network which provides the best quality of service (Qos), each application require different quality of service (QoS), and so the network selection may vary

accordingly. To achieve this goal and to select the best network for a mobile device, when moving from one network to another, it is necessary to have a good decision making algorithm which selects the best network for a specific application depending on user preferences. Therefore, the objective of our research is to design an optimum vertical handoff (VHO) decision algorithm:

- To carry out the extensive literature review for the existing Vertical handoff algorithms in next generation networks.
- To design & verify the existing Vertical handoff algorithms
- To make proper utilization of network resources (Band width) and to provide improvised quality of service (QoS) to real time applications.
- To reduce the handoff call dropping rate.
- To initiate a handoff at the right time.

Proposed Methodology:

In this work, we aim to provide a new handoff decision technique, which will overcome the aforesaid drawbacks that are present in the existing methods. Here, we propose a vertical handoff (VHO) decision algorithm to select the best base station based on network perspective as well as on user perspective. In our proposed technique, the best base station is computed by collecting some precise parameters from the available base stations in the network. The collected parameters will be predicted received signal strength (PRSS), velocity of the mobile station, user preferences, cost of the service, available bandwidth (B.W), received signal strength (RSS), jitter, delay and type of application. After evaluation of these parameters, weights will be computed for those collected parameters and subsequently future values for each base station's received signal strength (RSS) will be envisaged by using the Prediction theory. Following that, all the parameters will be used to determine the handoff factor. If the handoff factor is greater than the predefined threshold value, then the current point of attachment of the base station will be routed to the appropriate network which is selected based on the merit funion/Handoff

Factor (HF). Otherwise, the mobile station will continue to work with the present network connection.

The process of developing a Vertical handoff comprises the following stages:

1. First of all, Handoff process is initiated depending upon various parameters like predicted received signal strength (PRSS), velocity of the mobile station, user preferences, cost of the service, available bandwidth (B.W), received signal strength (RSS), jitter, delay and type of application.

2. Once the handoff process is initiated, the information about the network and mobile node is gathered from network layer, transport layer and application layer.
3. The collected information is used to determine a merit function/ Handoff factor.
4. After that, these values are passed to a decision algorithm.

Proposed handoff decision algorithm: Handoff decision algorithm is divided into three phases:

a) **Network discovery phase**: It discovers all the candidate networks with which a mobile node can connect. After that it assigns the priority to all networks based on received signal strength (RSS).

b) **Network analysis phase**: A Handoff Factor (HF) is calculated for all candidate networks. A Handoff Factor (HF) is a function of predicted received signal strength (PRSS), velocity of the mobile station, user preferences, cost of the service, available bandwidth (B.W), received signal strength (RSS), jitter, delay and type of application.

c) **Decision phase**: After analyzing the network, the network is selected depending upon the Handoff Factor (HF). A network with the highest value of Handoff Factor (HF) will be the best network to connect.

Proposed /Expected outcome of the research:

Our proposed technique will successfully select the best base station for accomplishing the handoff decision. The proposed handoff decision technique will be implemented in the working platform of MATLAB and the results will be analyzed to demonstrate the performance of the proposed handoff decision technique.

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